

Development of a Remote-Sensing Based Framework for Mapping Drought over North America

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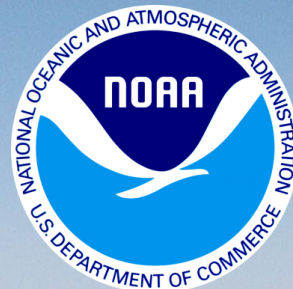
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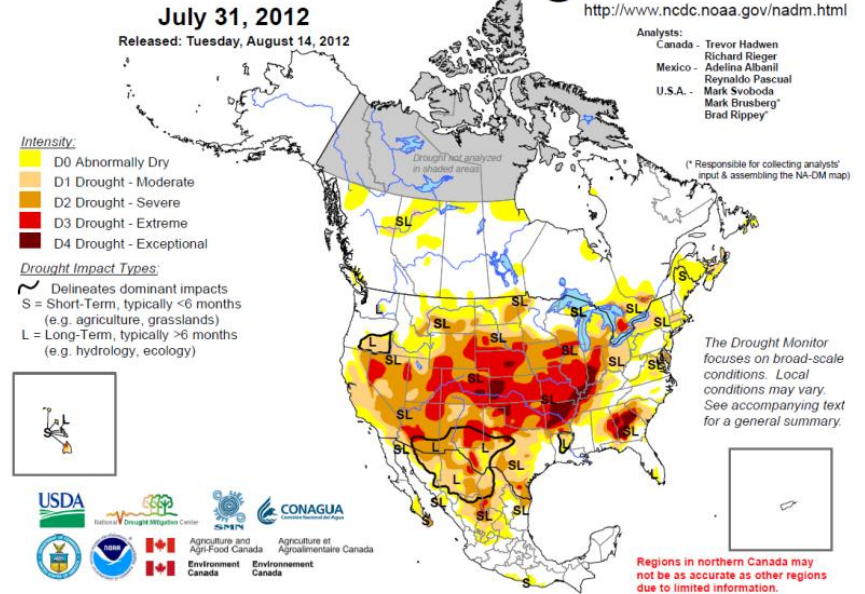
North American Drought Monitoring

The impacts of drought do not adhere to political boundaries and can have profound impacts on water compacts between countries, food security, commodity prices and geopolitics.

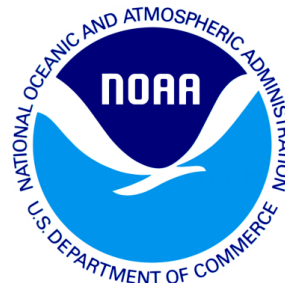
Expected Project Outcome:

- The ALEXI Evaporative Stress Index (ESI) has been shown to be an effective, fast-response indicator for monitoring agricultural drought over CONUS.
- The ESI uses GOES-derived land-surface temperature data to assess crop and soil moisture stress, and is an independent check on precipitation-based indices.
- To address the need for additional remote sensing-based drought monitoring tools covering North America, the current ESI domain will be expanded to include Canada, Mexico and Central America.
- The expanded ESI dataset will be evaluated with standard drought indices and available crop condition data and delivered to end-users at NOAA/CPC, NDMC and NASS by the end of Stage I.

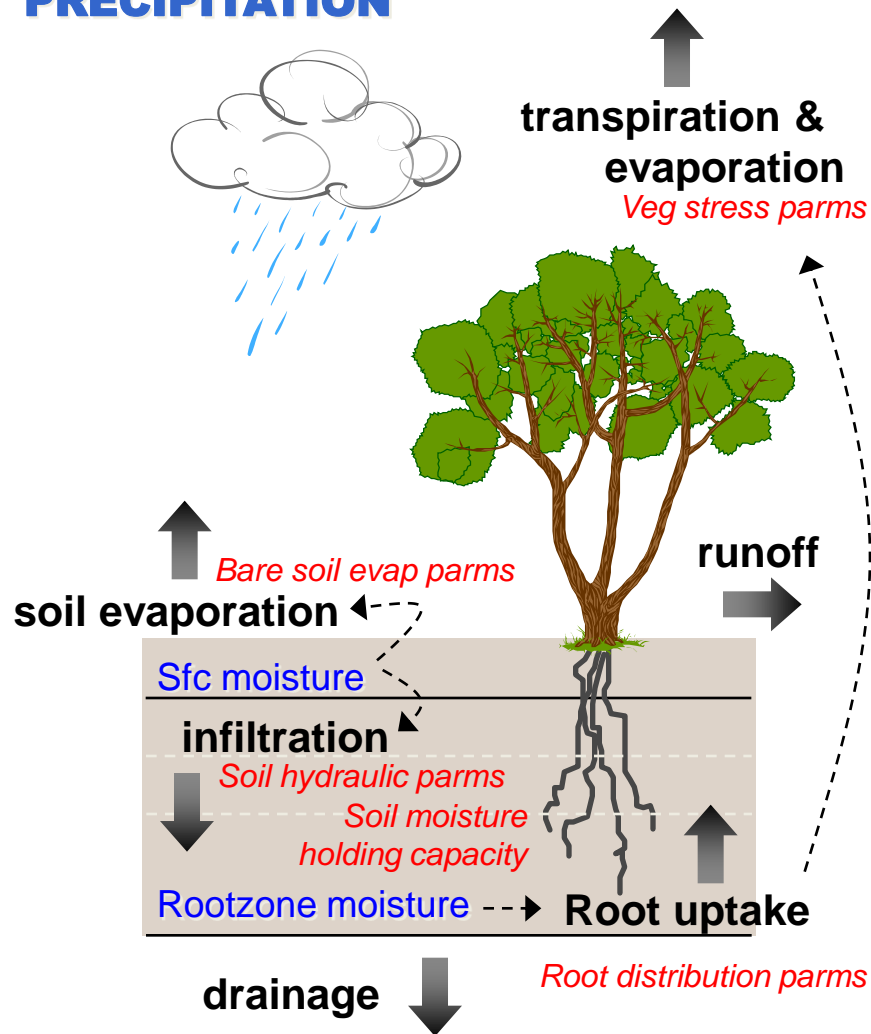
North American Drought Monitor



Project Partners:

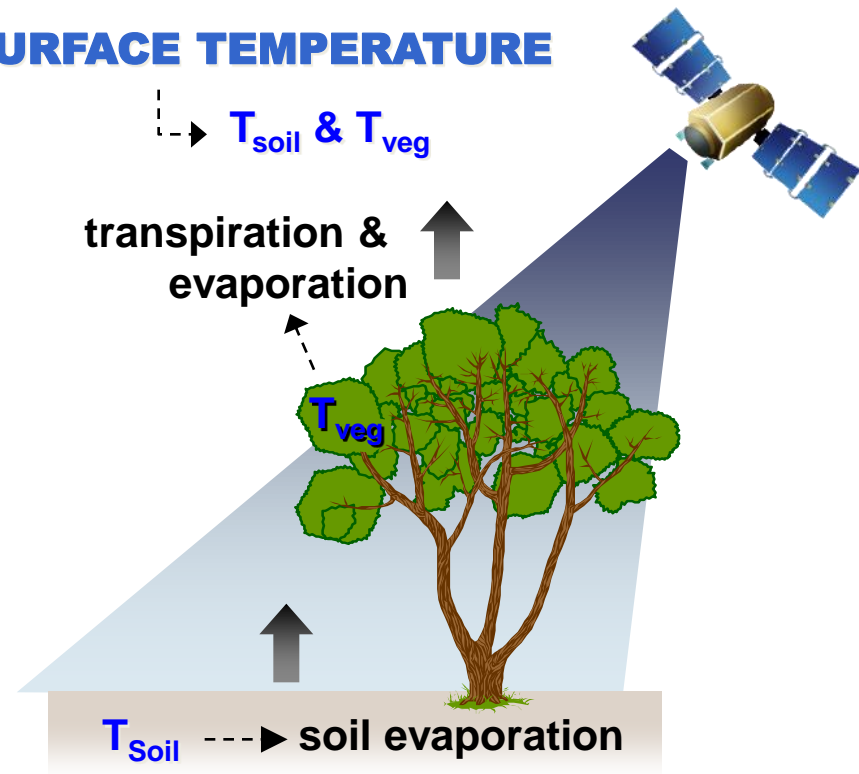


PRECIPITATION



WATER BALANCE APPROACH
("forward modeling")

SURFACE TEMPERATURE



Given known radiative energy inputs,
how much water loss is required to keep
the soil and vegetation at the observed
temperatures?

REMOTE SENSING APPROACH
("inverse modeling")

ESI Methodology

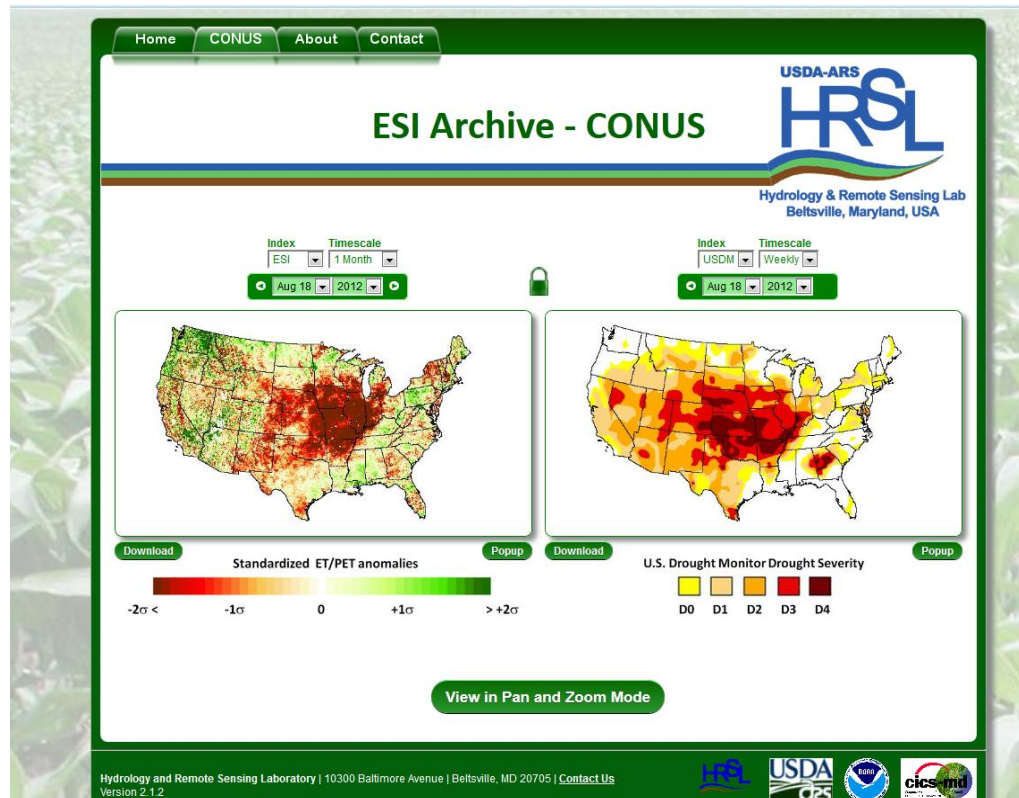
ALEXI ESI represents temporal anomalies in the ratio of actual ET to potential ET.

- ESI does not require precipitation data, ***the current surface moisture state is deduced directly from the remotely sensed LST***, therefore it may be more robust in regions with minimal in-situ precipitation monitoring.
- Signatures of vegetation stress are manifested in the LST signal before any deterioration of vegetation cover occurs, for as example as indicated in NDVI, so TIR-based indices such as ESI can provide an effective early warning signal of impending agricultural drought.
- ALEXI ESI inherently includes non-precipitation related moisture signals (such as irrigation; vegetation rooted to groundwater; lateral flows) that need to be modeled a priori in prognostic LSM schemes.
- ALEXI ESI provides an independent assessment of current drought conditions, supplementing precipitation and modeling-based indices – an invaluable resource to decision-makers who usually depend on a convergence of information in the decision making process.

Data	Purpose	Source	Spatial Resolution	Temporal Resolution
LST	ΔT_{rad} , RN	GOES	12 km	1 hr
LAI	T_{rad} partitioning	MODIS	0.01°	8-day
Insolation	RN	GOES	12 km	1 hr
Longwave radiation	RN	GOES	12 km	1 hr
Albedo	RN	MODIS	0.05°	16-day
Wind Speed	Aerodynamic resistances	GEOS-5/MERRA	0.66°x0.50°	1 hr
Atmos lapse [$d\theta/dz$]	ABL growth model	GEOS-5/MERRA	1.25°	3 hr
Landcover type	Canopy characteristics	MODIS	0.05	fixed

Stage I Project Impacts: North American ESI Climatology (2000-present)

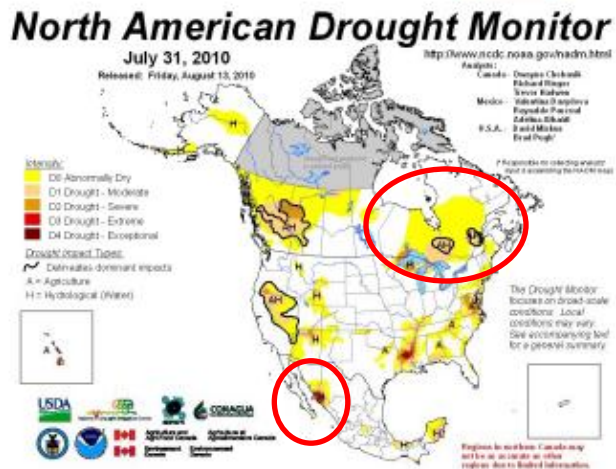
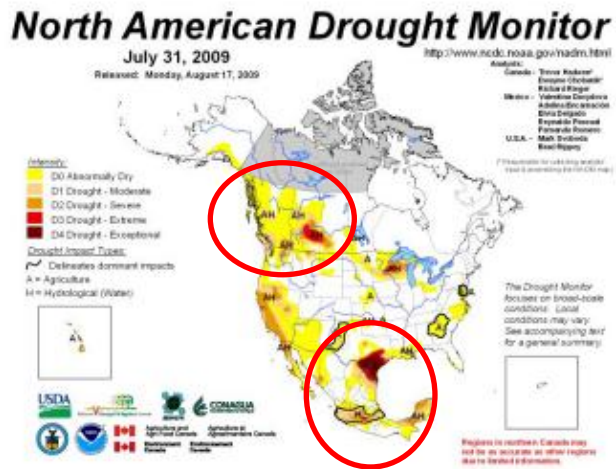
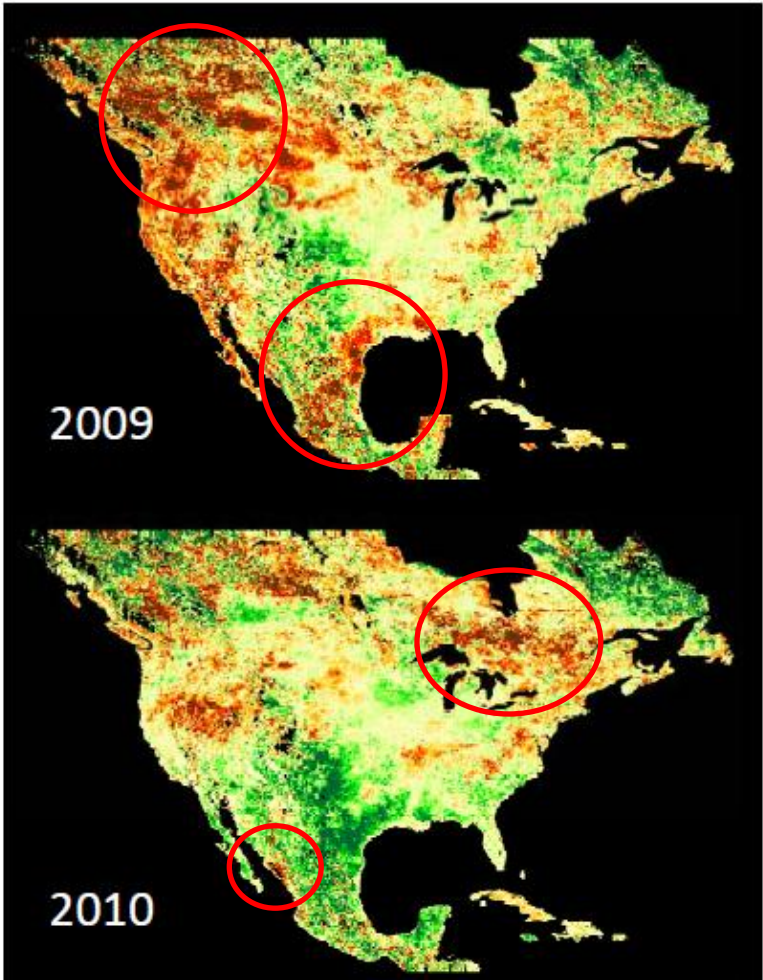
- During the 1st half of the Stage I period, the project will generate an archive of ALEXI ESI drought maps over North America and conduct an extensive inter-comparison with standard drought indices for 2000-present.
- During the 2nd half of the Stage I period, ALEXI ESI maps (realtime+historical) will be disseminated to end-users in CPC, NDMC, and NASS for evaluation in preparation for a potential Stage II implementation.



- In preparation for a potential Stage II of the project, the project team is working with NOAA to formalize plans for a transition to operations through NESDIS' Office of Satellite Product Operations (OSPO), which would provide Stage II "shared-funding" for operationalization and be responsible for 24/7 system execution of the North American ESI system beyond the life cycle of this project.

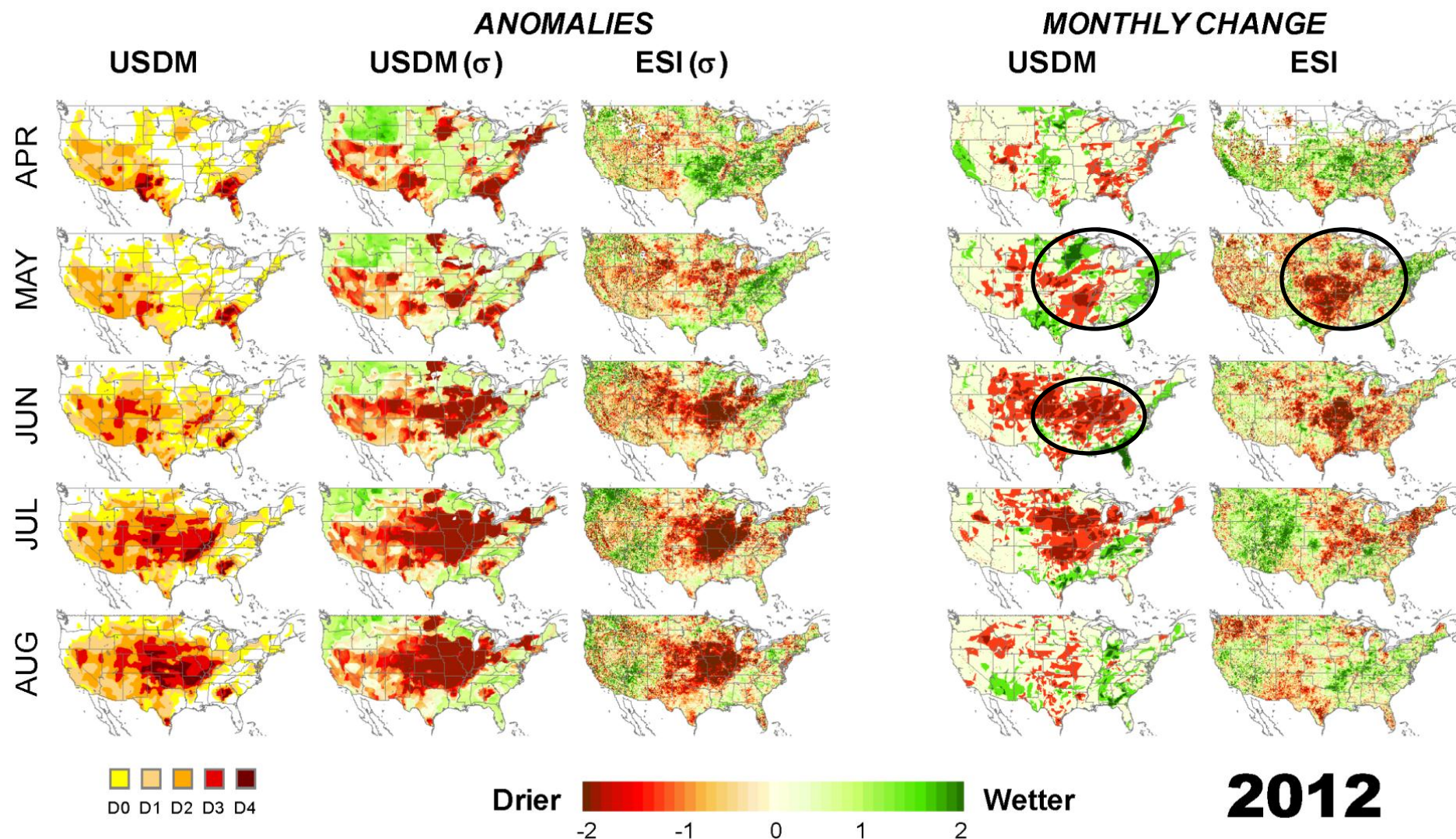
Stage I Project Impacts: North American ESI Climatology (2000-present)

Early results from a limited subset of the full data record...



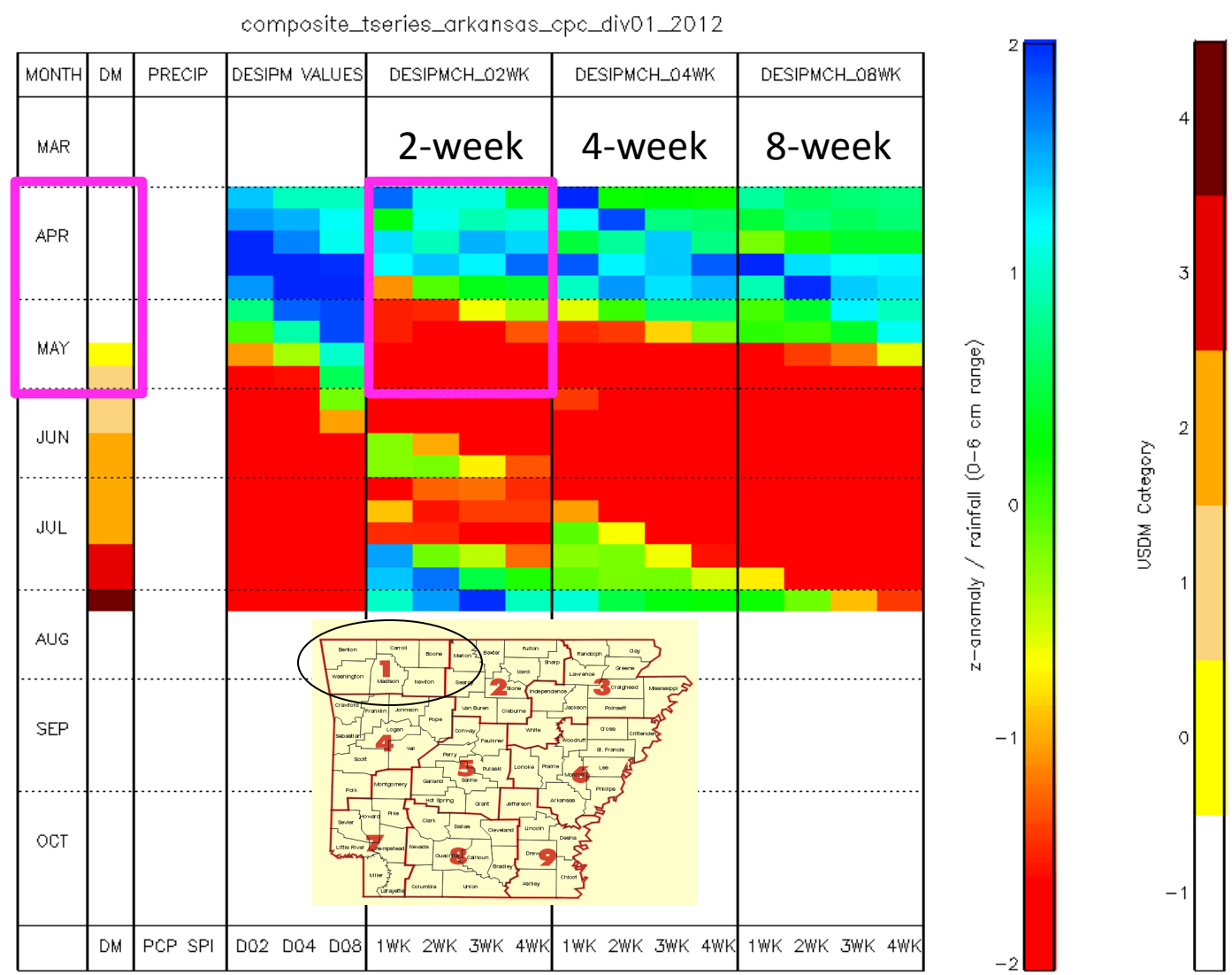
Stage I Project Impacts: A Drought Early Warning Tool

- Monitoring changes in ESI (Δ ESI) and in USDM drought classifications have shown the utility of the change product in providing clear early warning indicating areas where soil moisture conditions are decaying rapidly.
- Δ ESI maps will be produced for the North American ESI domain and provided to end-users for evaluation.

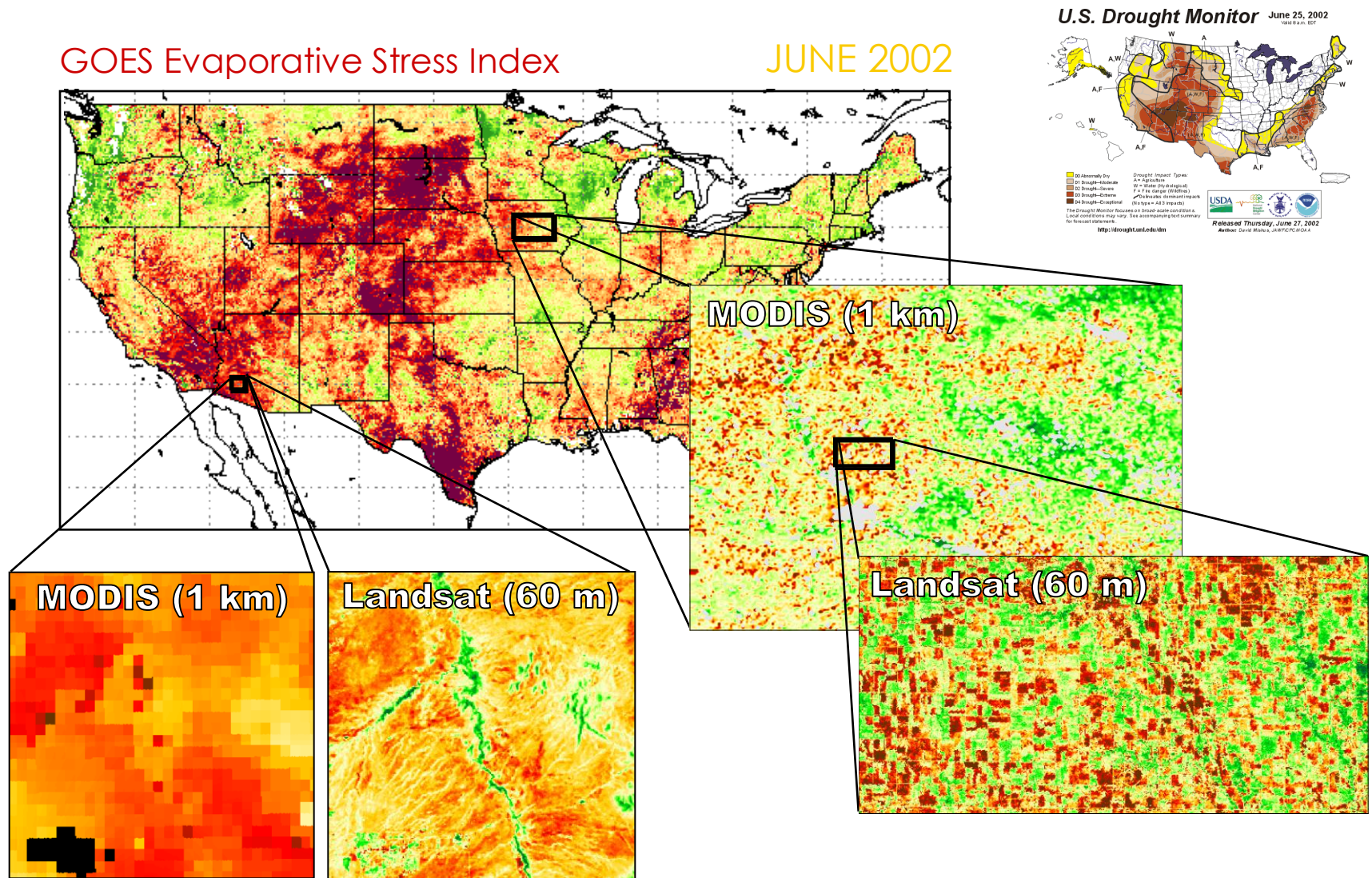


Stage I Project Impacts: A Drought Early Warning Tool

- Maps of Δ ESI are useful to end-users for denoting spatial changes in ESI, however, finding an effective medium for monitoring temporal changes of ESI over a regional area (e.g., watershed, climate division) shows an additional benefit of this metric.



Stage I Project Impacts: Demonstration of Multi-scale Drought Monitoring



- A demonstration of a multi-scale ESI assessment will be performed for a select number of regional drought events within the historical record and provided to end-users for feedback on relevant applications for ESI information at various spatial scales.